Public Health Procedures used to Classify Shellfish Growing Areas

Presentation to the Aquaculture Enhancement Zone TAC

March 18, 2008

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The National Shellfish Sanitation Program

- States must participate in the NSSP in order to ship <u>bivalve</u> <u>molluscan</u> <u>shellfish</u> interstate.

- The US Food and Drug Administration has responsibility for oversight of the NSSP, though it is a cooperative program between the FDA, states and the industry.

- The Interstate Shellfish Sanitation Conference is the primary arena where program changes are cooperatively developed.

Public Health Concerns with Shellfish

- Filter feeders pump large quantities of water daily and the gut contents are often eaten raw or partially cooked

- Substances in the water are concentrated within the gut and body tissue (*e.g.*, viruses to 900 times that of the overlying water)

- Once harvested, some types of pathogenic bacteria can grow to higher concentrations if temperature abused

Human Pathogenic <u>Bacteria</u> of Potential Concern in Shellfish

Contamination via fecal/oral route

- *Salmonella, Shigella, Campylobacter*

Sources:

- Nonpoint: septic, wildlife, cattle, etc
- Point: boats, waste treatment facilities

Naturally occurring

- Vibrio parahaemolyticus, V. vulnificus, V. cholerae (non-O1)

Human Pathogenic Viruses of Potential Concern in Shellfish

Contamination via fecal/oral route
- Norovirus, Hepatitis A, Hepatitis E
- 10 to 100 Noroviruses estimated to trigger disease

Sources must be human
- Nonpoint: septic, no facilities, etc
- Point: boats, waste treatment facilities

Survive
- Chlorine (fairly well)
- UV treatment (somewhat)
- estuarine conditions for approximately 30 days
- normal minimal cooking (*e.g.*, light frying)

None occur naturally

Human Pathogenic Parasites of Potential Concern in Shellfish

Contamination via fecal/oral route

- *Cryptosporidium parvum*

Sources:

- Nonpoint: human, pre-weaned cattle, deer

- Point: boats, waste treatment facilities

No known cases of shellfish-borne disease

Other Substances Potentially of Concern in Shellfish

- Toxic substances and Heavy Metals

  - Pesticides, PCBs, antibiotics etc.

  - DSS collects samples and DCLS analyzes, no contaminants exceed FDA tolerance levels except potentially in the Elizabeth River

- Harmful Algal Blooms

  - PSP, NSP, ASP, DSP

  - DSS, DEQ, ODU monitor for species & toxins

  - no VA shellfish found with levels of public health significance

Virginia Department Of Health Division Of Shellfish Sanitation Shellfish Growing Areas

1 inch equals 6 miles
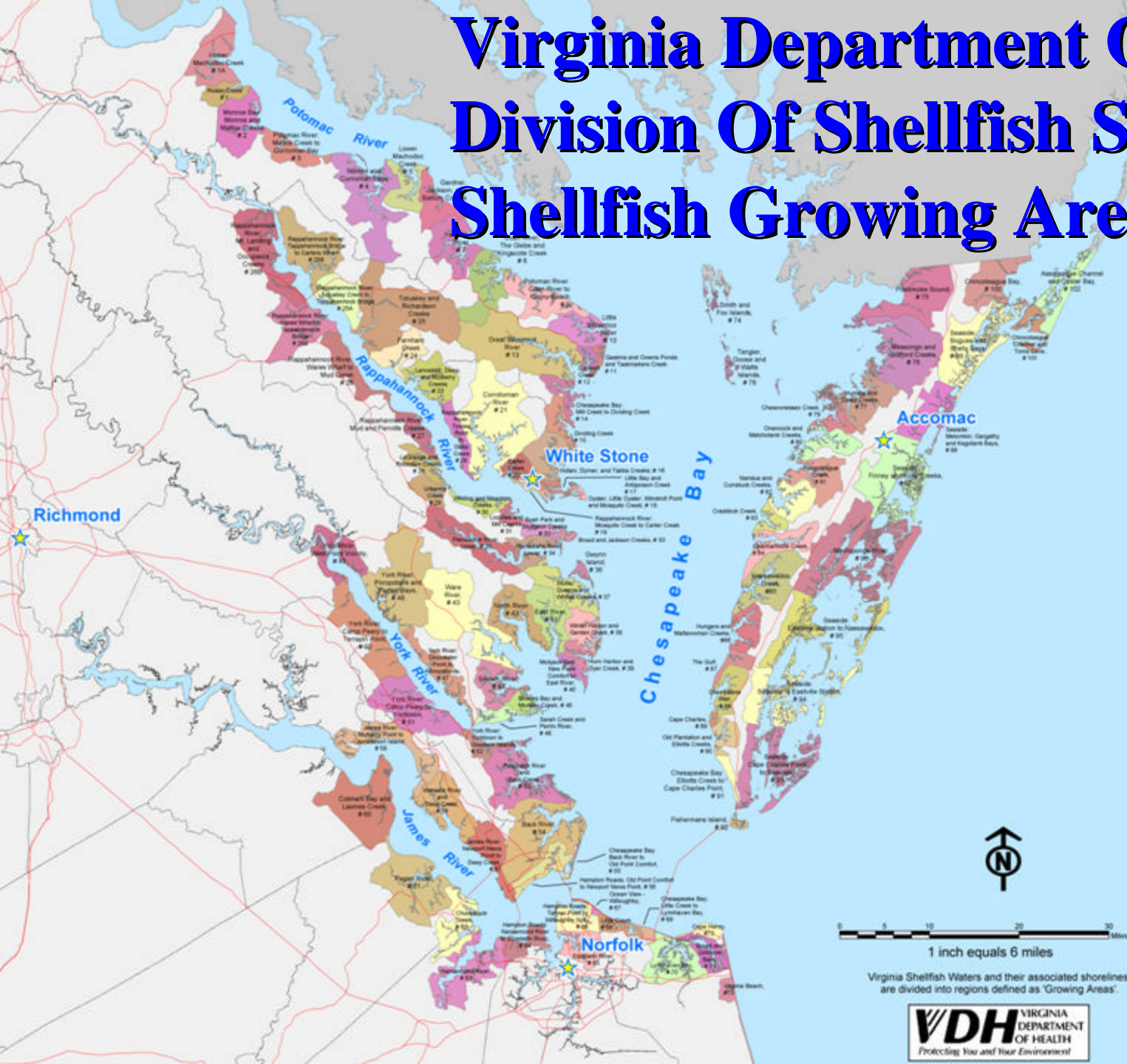
Virginia Shellfish Waters and their associated shorelines
are divided into regions defined as 'Growing Areas'.

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

Employed and Evolving Techniques for Classifying Growing Areas

- shoreline survey (DSS investigations, Marina Program data, DEQ NPDES permit data)
- microbiological analysis (fecal, vibrios, *Norovirus*)
- phytoplankton for biotoxin potential
- shellfish meat samples for biotoxins
- shellfish meat samples for toxic substances and heavy metals
- fluorometric studies for optical brighteners in leachate
- dye studies
- drogue studies
- GIS with aerial photography

Shoreline Survey

- Classification begins with an upland, near-shore evaluation primarily for potential sources of fresh fecal contamination
- Property-by-property evaluation of:
  - Onsite sanitary waste disposal facilities
  - Potential sources of animal pollution
  - 5,475 properties inspected in 2007
    - 2509 on the Eastern Shore
- Marina surveys of number and sizes of boats
- NPDES permits
- Report with map developed and put on VDH web page

Fluorometry Studies using Optical Brighteners as Indicators of Potential Drainfield Leachate

- Optical brighteners are used in laundry and dishwashing detergents
- They are long-lived in septic tanks
- Filters for fluorometers optimize sensitivity to brighteners
- Subsurface leachate from septic tank drainfields can be detected as a spike above background
- Evaluation must be conducted during the latter part of ebb tide - thus time consuming

Detection of Optical Brighteners from Human Sources of Fecal Pollution

C. Hagedorn, M. Saluta, R. B. Reneau, A. Hassall
## Virginia Tech

**Confirmation: Coan and Little Wicomico Rivers –
Fluorescent plumes were found.
These could easily be followed to shore.
With MST, human signature also found in the plumes.**

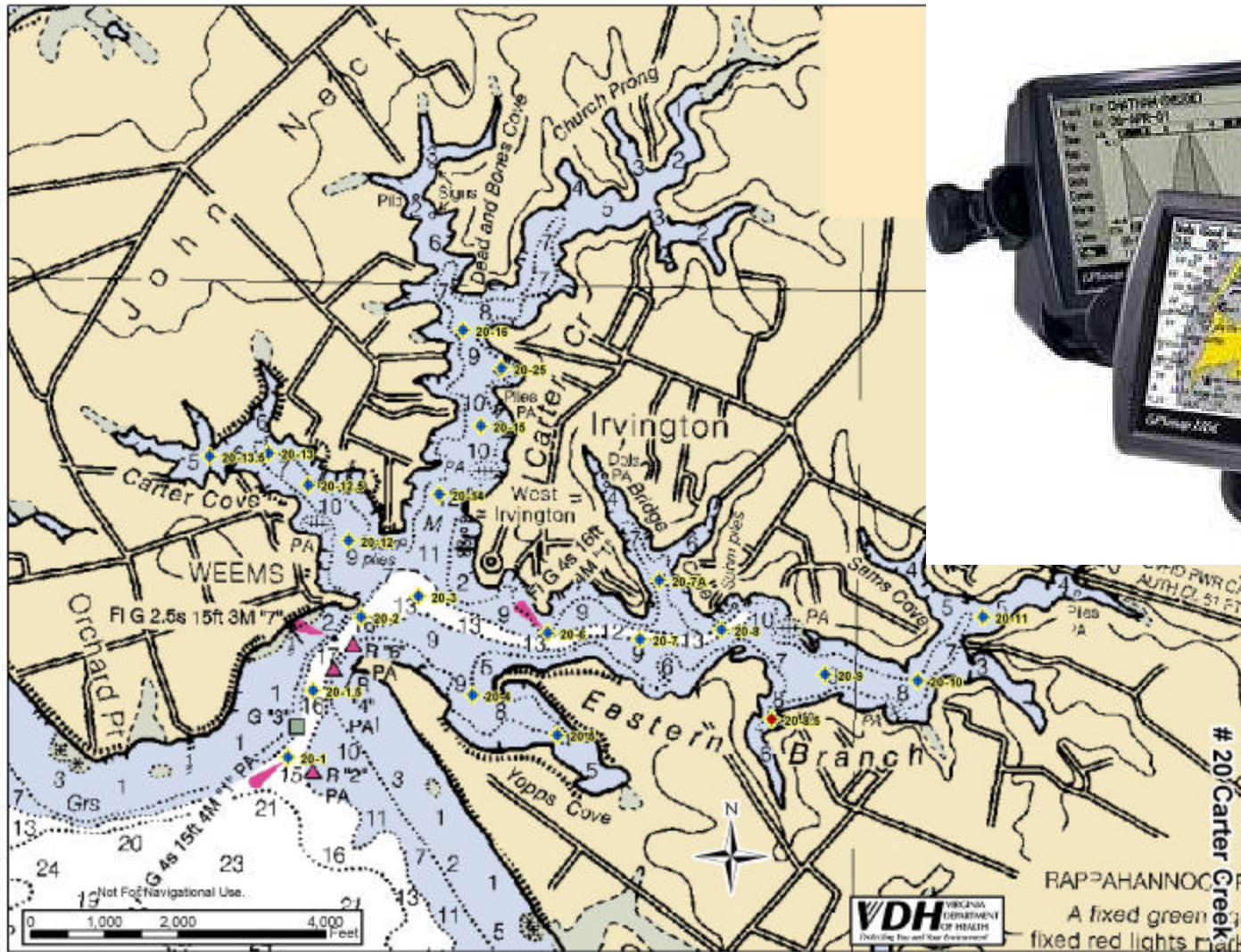# Administrative Closure - Chincoteague Island
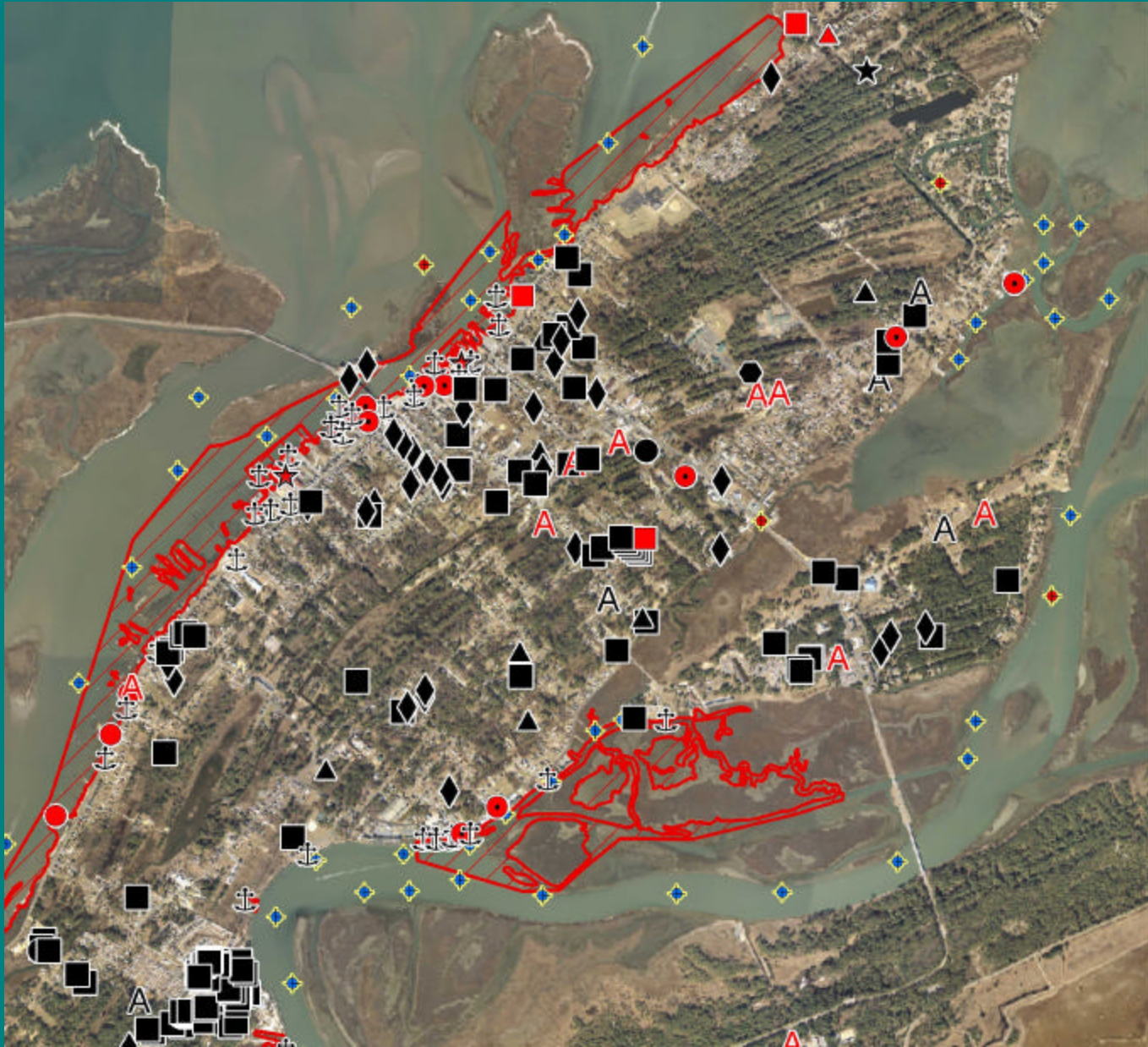
Seawater Sampling Program

Seawater Stations are Primarily Located in the Subtributaries and
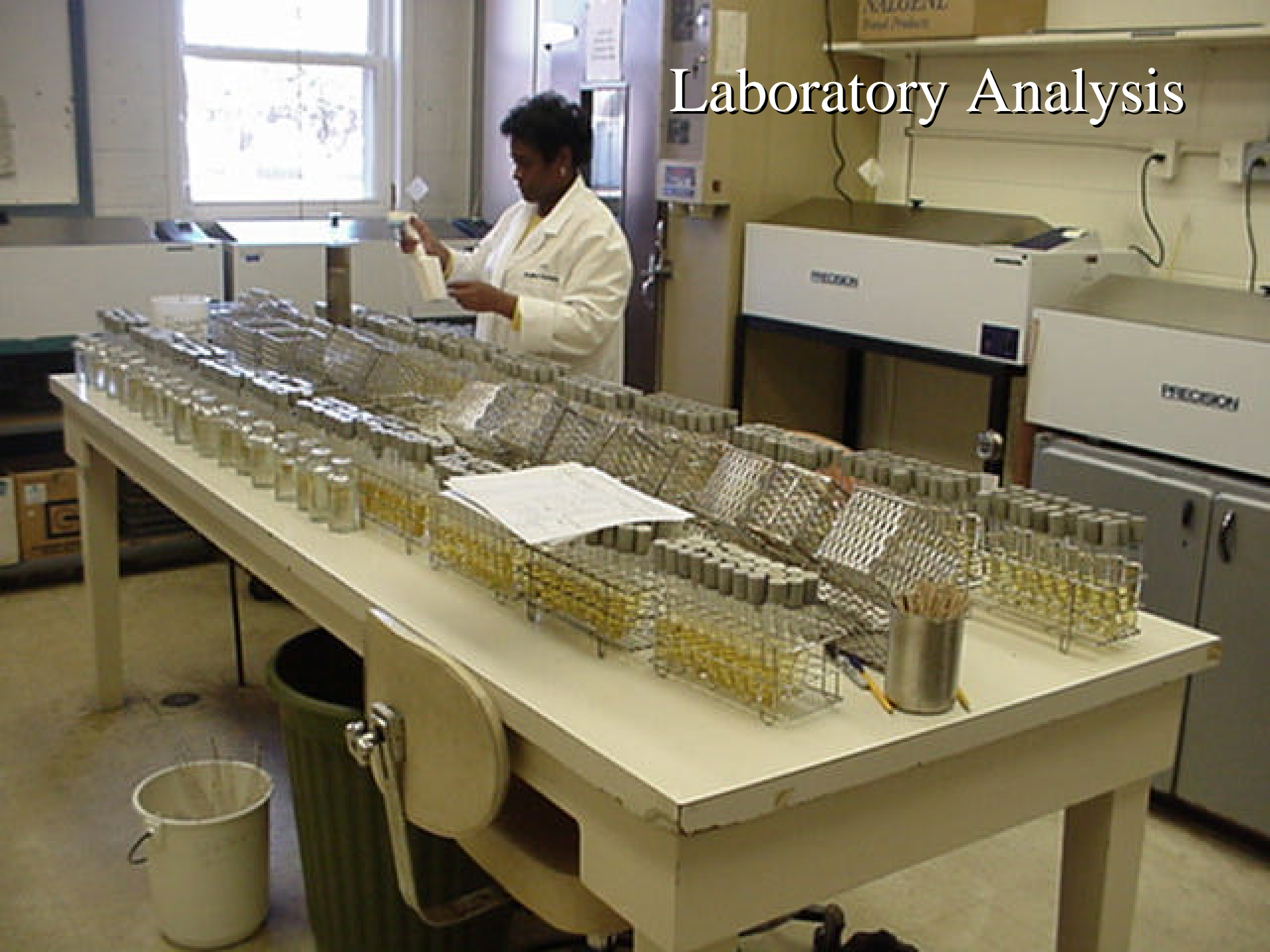# Samples are Analyzed for Fecal Coliforms
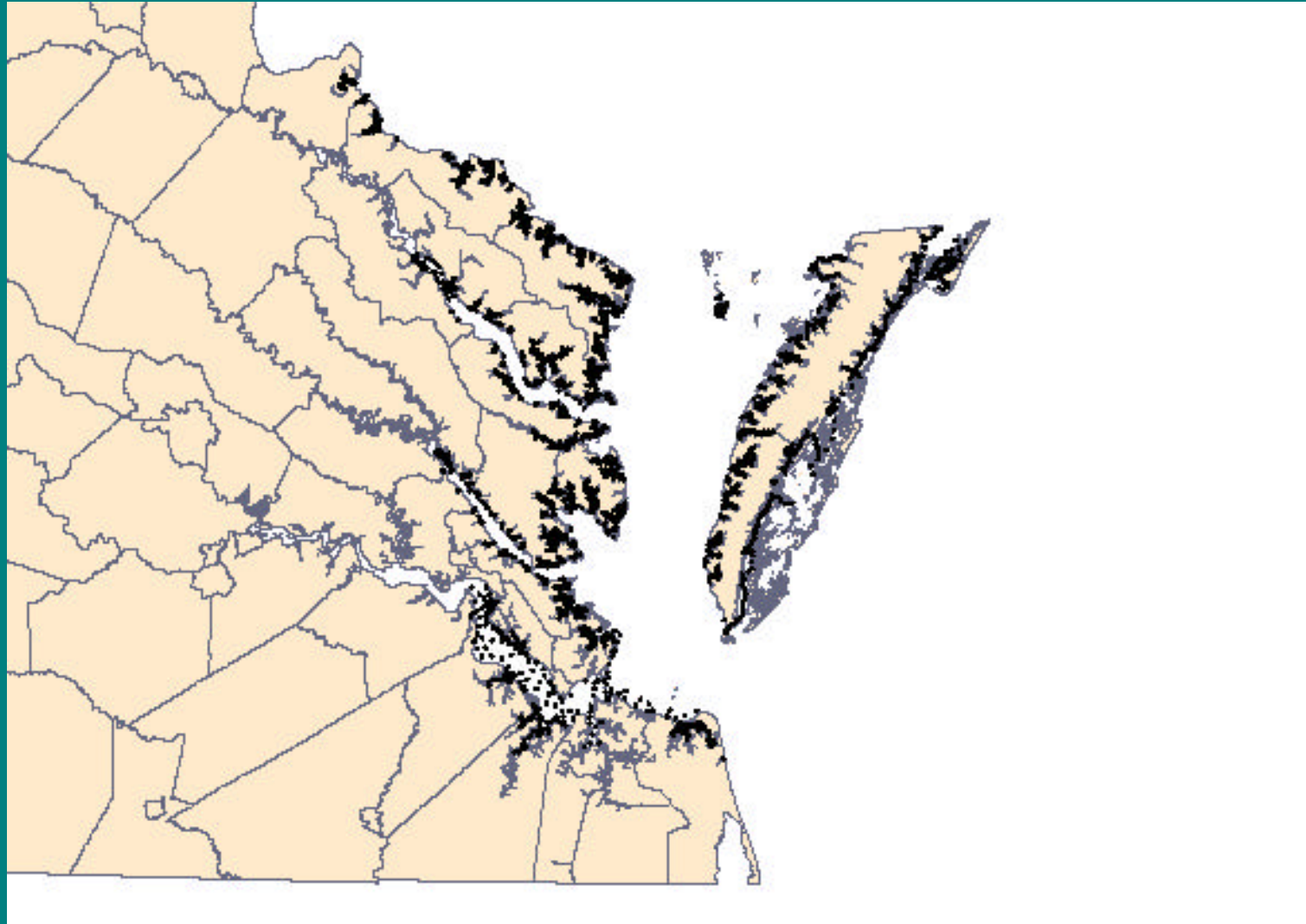
GPS Guided Seawater Sampling

Typical Sampling Station Pattern
Little Wicomico River at Smith Point

Laboratory Analysis

Membrane Filtration followed by Direct Plating Analysis (mTEC) is now being used

- The Division is converting from multiple tube fermentation, as shown in the previous slide, to filtration and direct plating, as shown in the next slide. This should provide more accurate results.

- Analyses are for the entire fecal coliform group

Fecal coliform analysis of seawater sampling stations fine tune the evaluation of the growing area

- 2170 Seawater sampling stations in the main tributaries and subtributaries of Tidewater Virginia
- Stations are generally sampled once per month, and sampling is scheduled a month ahead to be random with respect to weather
- 21,200 seawater samples analyzed in 2007
  - 7,145 seawater samples on the Eastern Shore

# Evaluation of Shellfish Areas for Public Health Safety

Shoreline Survey Information

- Review of known pollution sources for potential impact, considerations:

  - magnitude of source

  - location on the watershed

  - potential to reach shellfish waters in an undetectable manner (*e.g.*, between sampling stations)

Seawater Data

- Application of growing area water standard is strictly applied

    - Use the most recent 30 samples

    - Geo. Mean of 14 fecal coliform/100 ml

    - Estimated 90th percentile

        - $\leq$ 49 when all MPN data used

        - $\leq$ 31 when all direct plate data used

        - weighted value between 49 and 31 when evaluating mixed MPN and direct plate data

Example use of seawater data to establish closed area
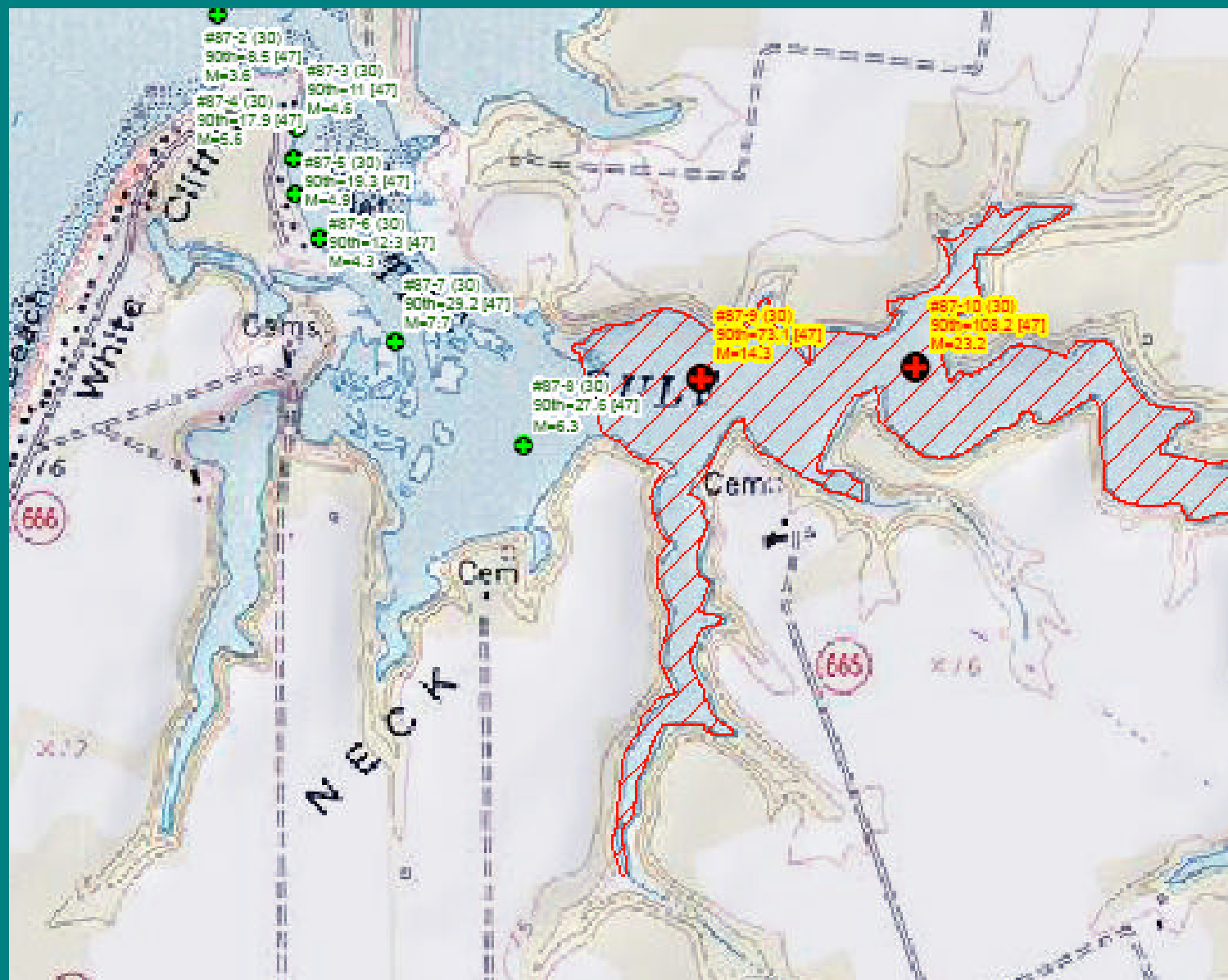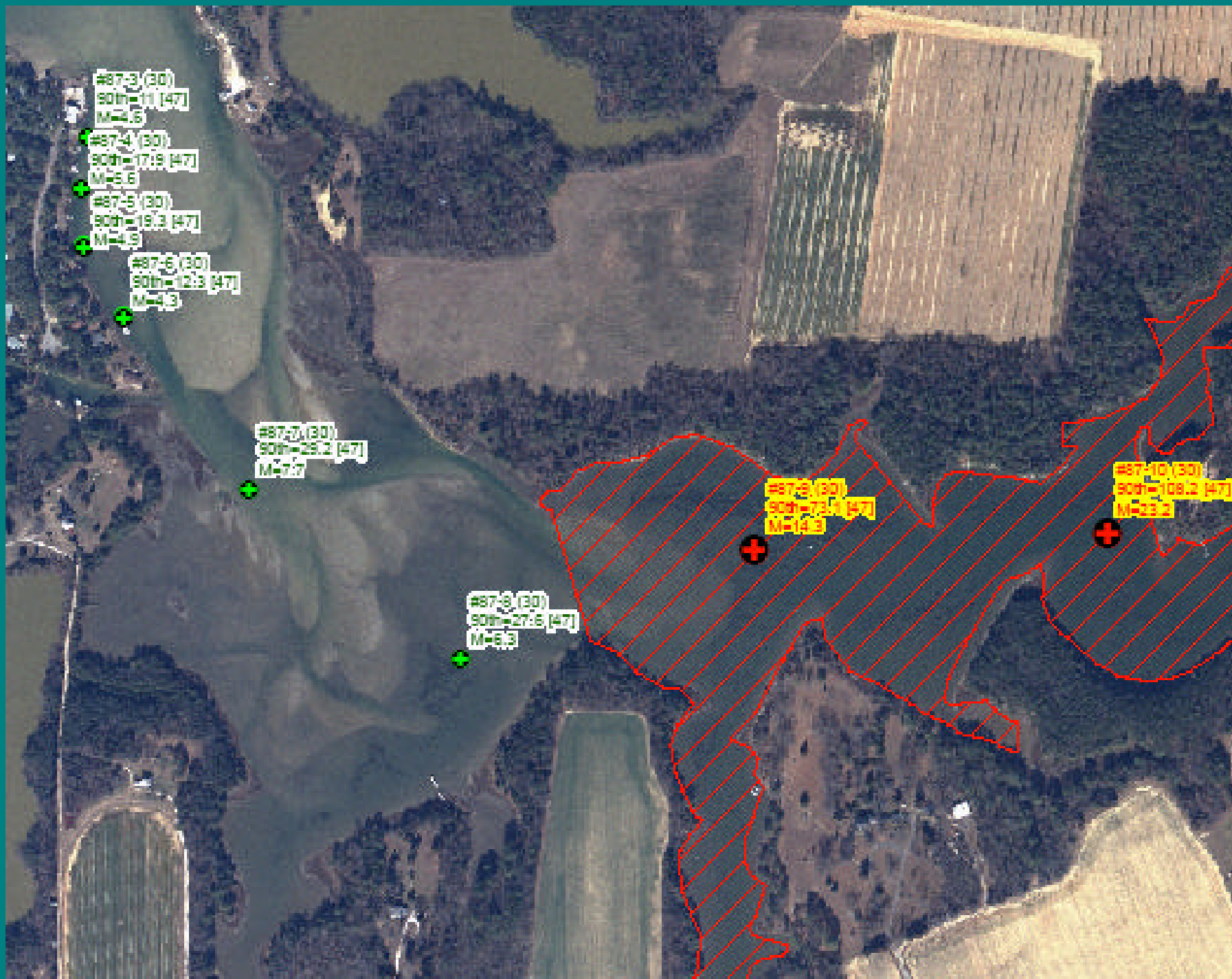
Virginia Department of Health
The Gulf
Condemned Shellfish Area Number 087-174
8 September 2006

0   500   1,000   2,000
Feet

Chesapeake
Bay
11-00-00

Smith Beach Rd

Condemned Shellfish Area
(Section A)

The Gulf
11-51-00

Toms Ln

(37°21'50.3",-75°58'43.3")

(37°21'45.8",-75°58'41.5")

Section
A

N

Northampton
County

Elkington Rd

Geographic coordinates in NAD83 datum;
shown in degrees, minutes & seconds.

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Use of Historical Data

The change in geometric means over time

Division of Shellfish Sanitation
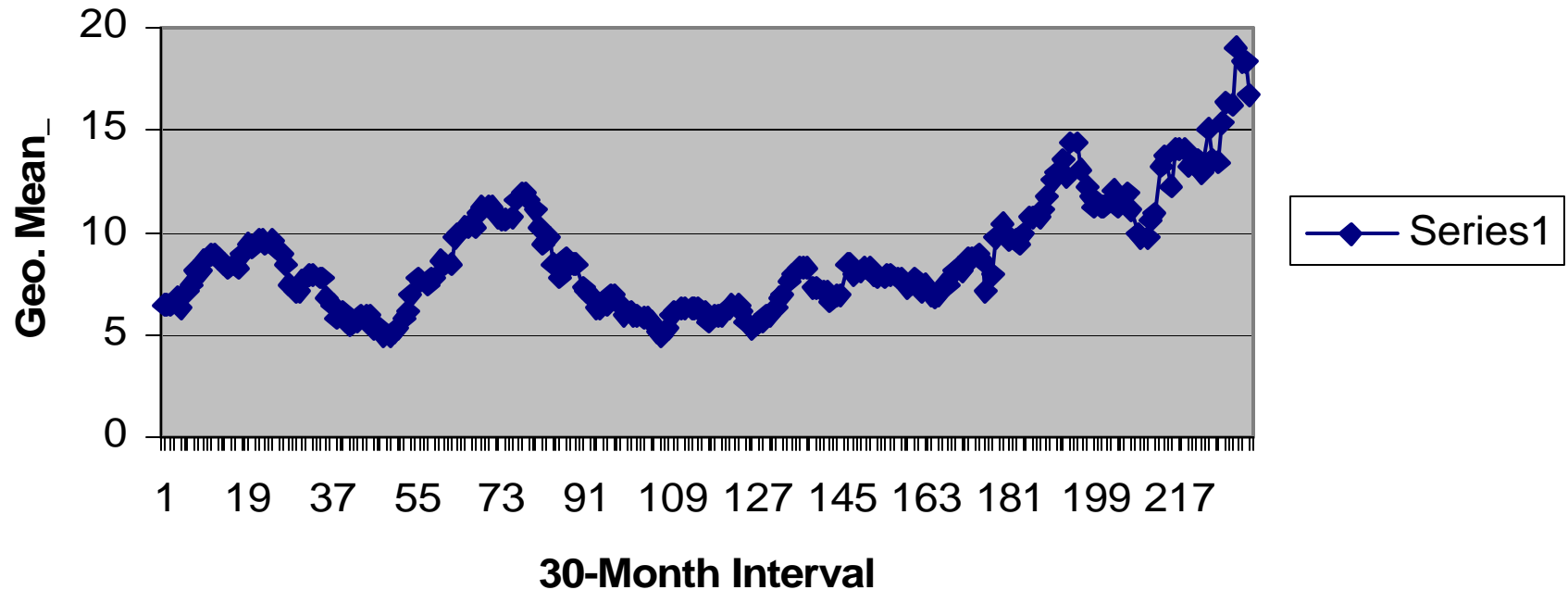# Sampling Stations North of Rt. 175 Bridge
Chincoteague, Virginia

Northwest Side of Island
20-Year data set; Geo. means of 30 samples
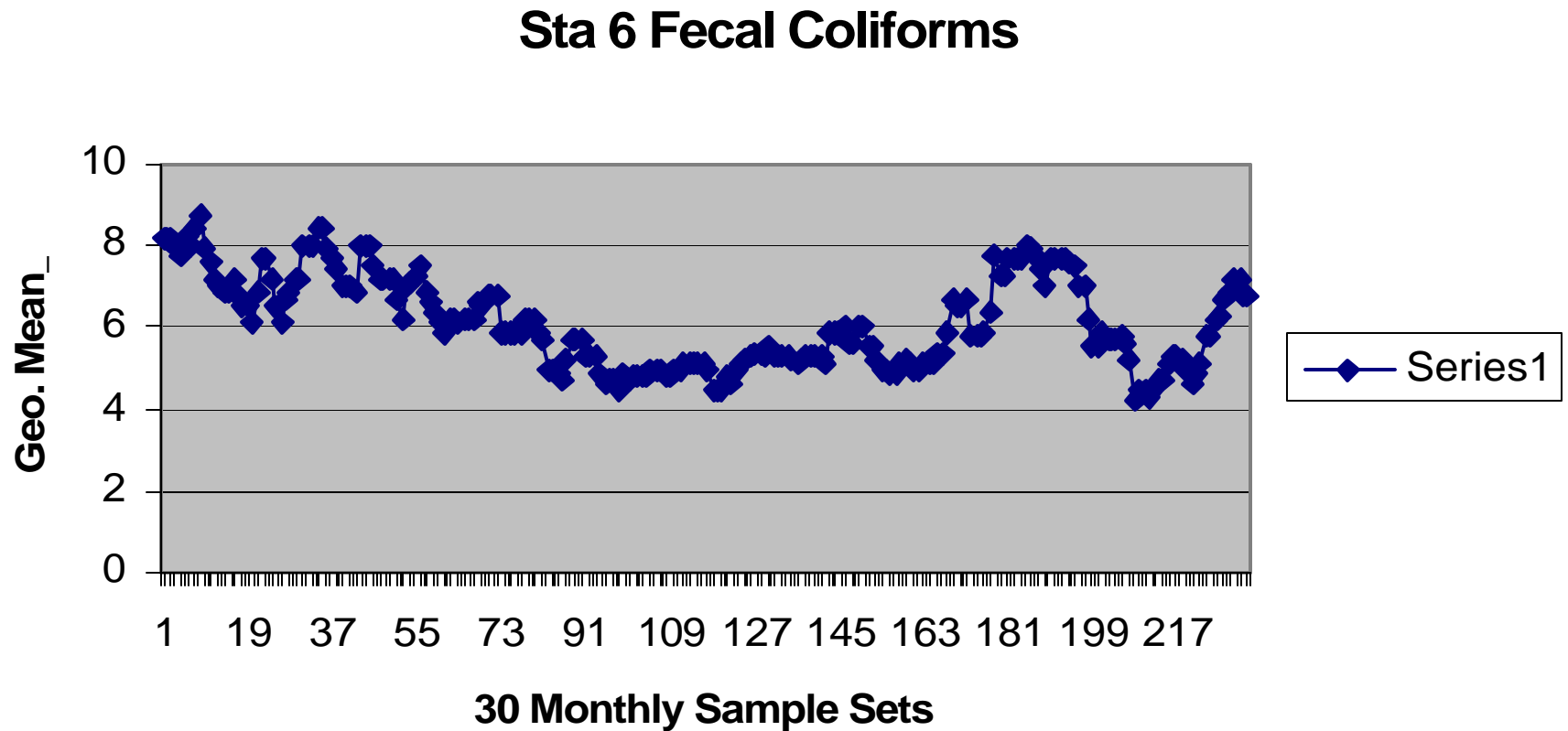Most recent at "1" and oldest at "217"
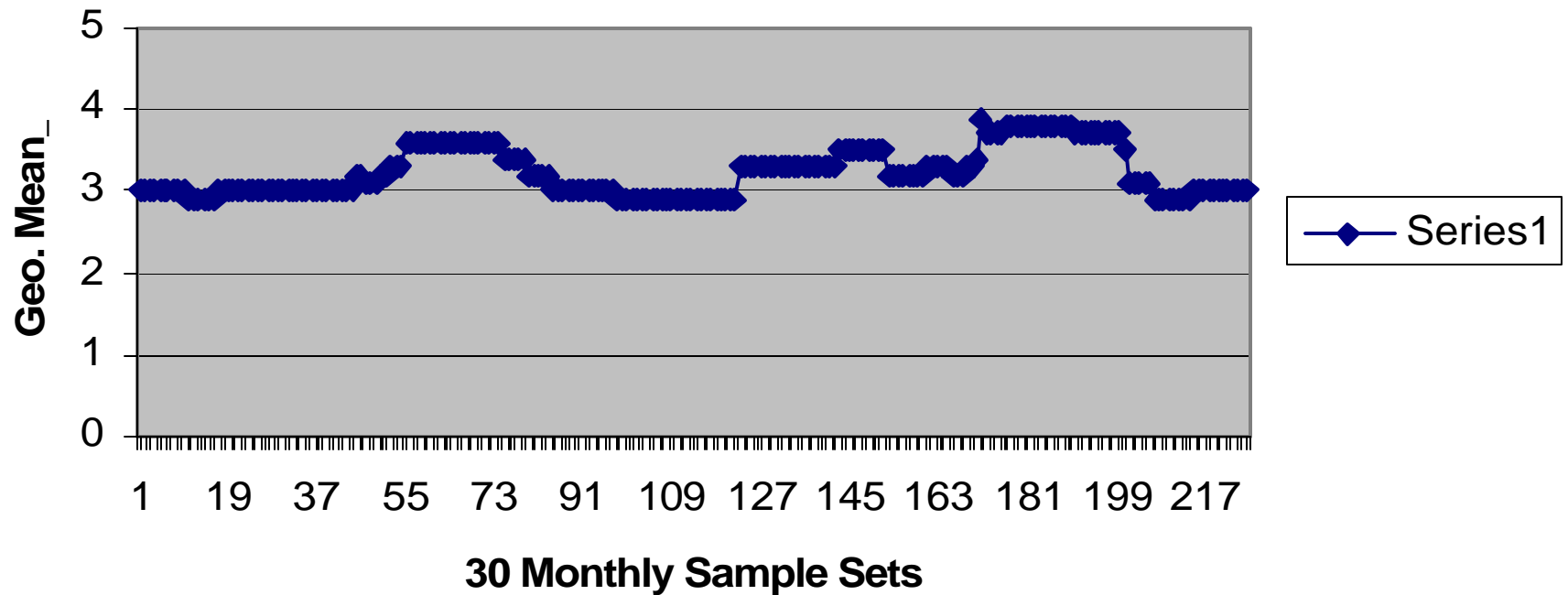
In Chincoteague Channel at Bridge
20-Year data set; Geo. means of 30 samples
Most recent at "1" and oldest at "217"

Sta. 13 Fecal Coliforms
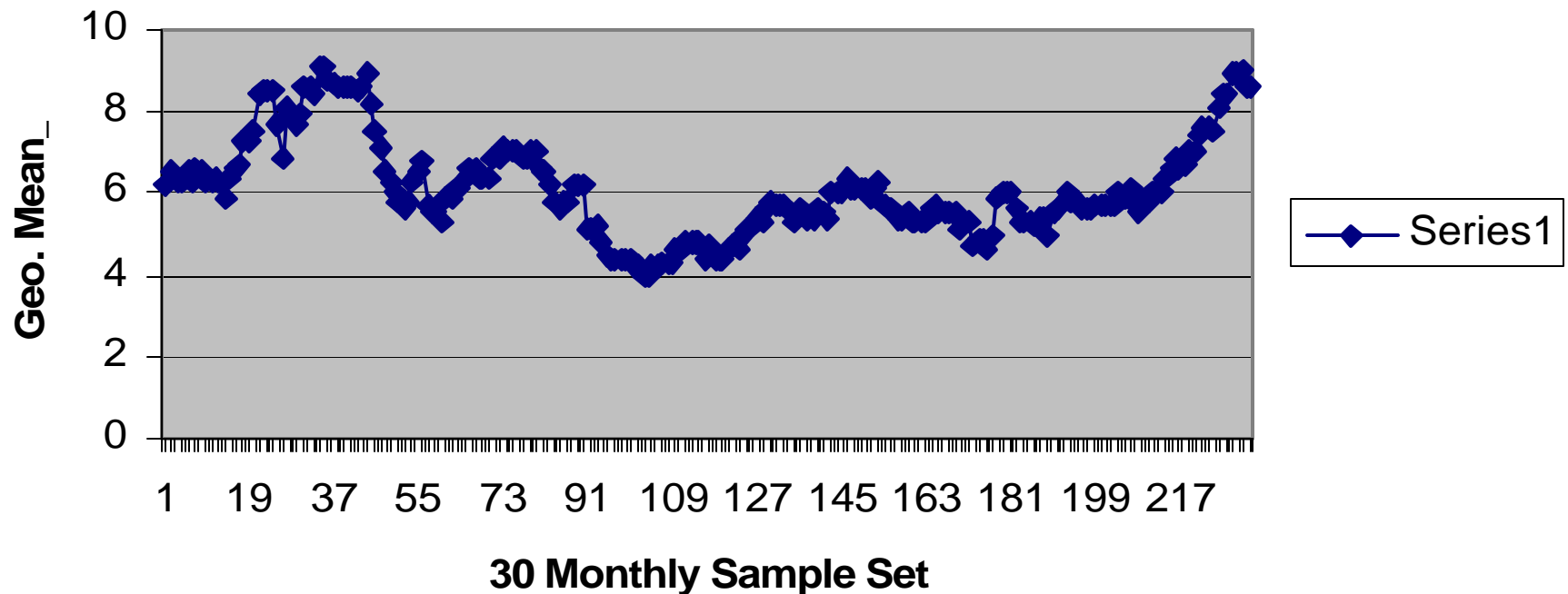
Midway between bridge and southern point
20-Year data set; Geo. means of 30 samples
Most recent at "1" and oldest at "217"

Sta 6 Fecal Coliforms
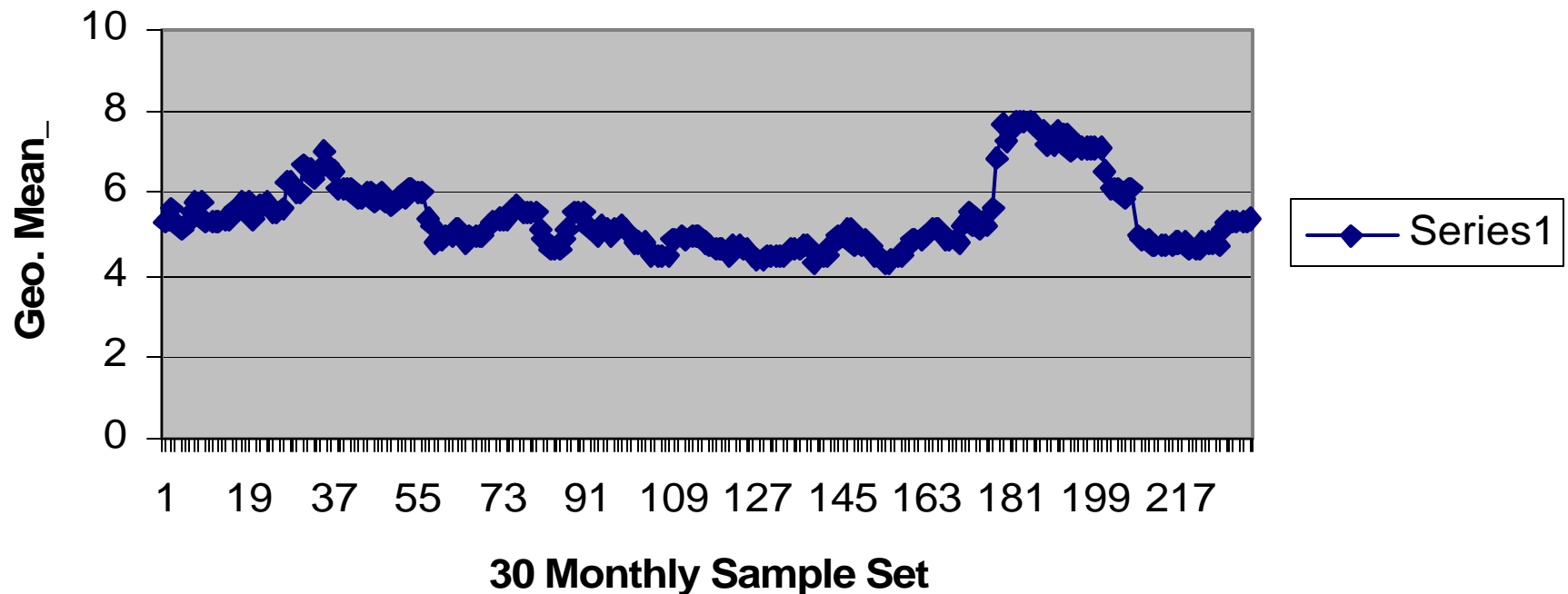
Division of Shellfish Sanitation
Sampling Stations South of Rt. 175 Bridge
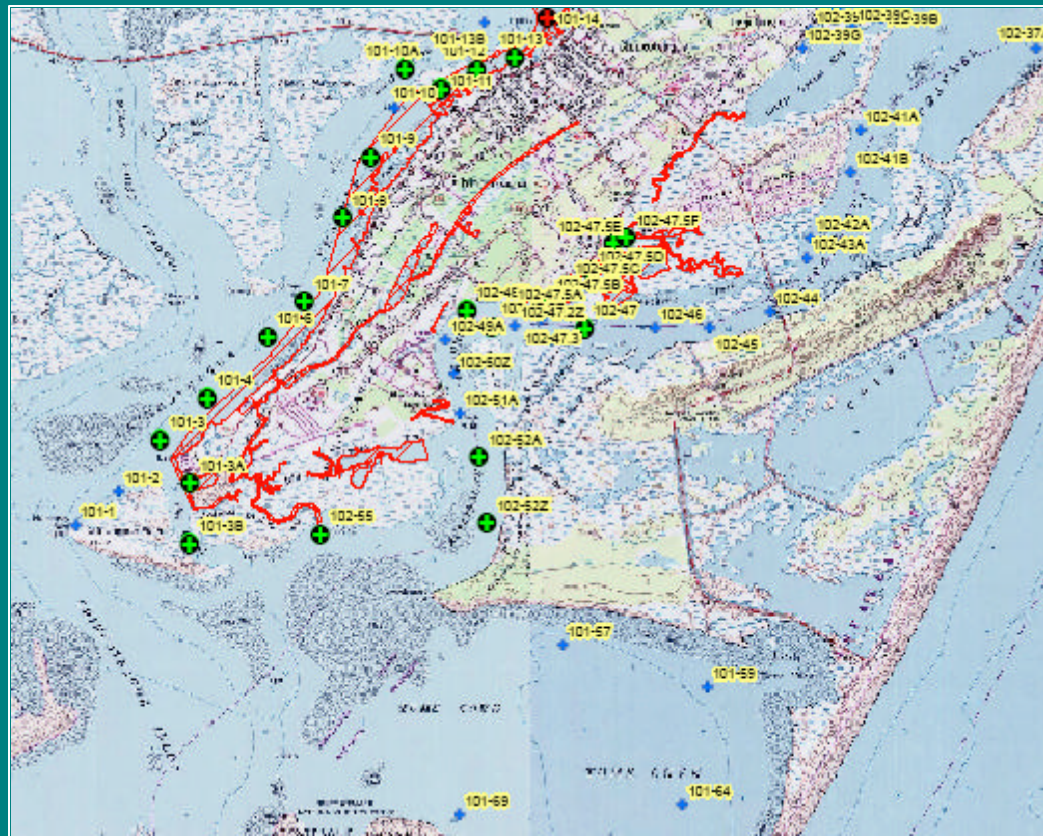
Evaluation of Point Sources

- Waste Water Treatment Facilities (WWTF)
- Marinas

Types of Condemnations Around Waste Water Treatment Facilities

- Prohibited Areas

  - located in the immediate vicinity of the discharge

  - no relay allowed

- Restricted Areas

  - surround the prohibited area

  - zone of lesser contamination

  - relay allowed (15 days, water $\geq$ 50° F)

Required Condemnation Zones around a Waste Water Treatment Plant
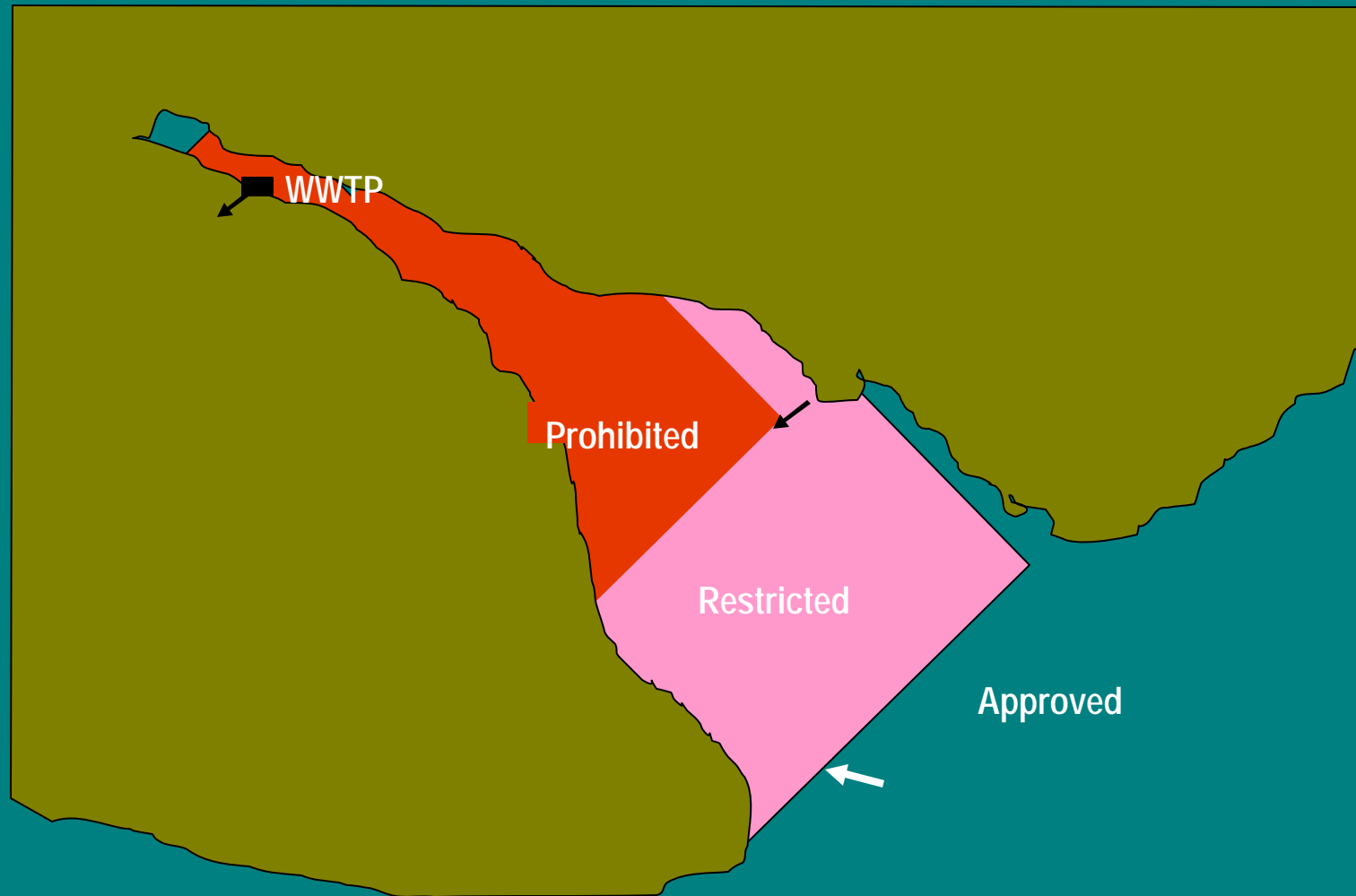
Virginia Department of Health
Chincoteague Channel and Vicinity
Condemned Shellfish Area Number 101-020
16 May 2007

Exemptions from the Need for Prohibited Shellfish Areas

- When the discharge is either far enough up on the watershed and very small, or located so far upstream as to not affect shellfish waters

- Initial discharge to a 24-day minimum detention pond (restricted area still needed but smaller)

Use of Computer Models to Establish Condemnations

- Mathematical models using "desk top accessible" hydrographic data with relatively sophisticated math

- Assumes a rectangular channel with some bottom roughness

- Model uses a discharge rate of fecal coliform input to the estuarine system and a die-off coefficient while calculating transport, dispersion and dilution - it runs to a steady-state condition

- Boundaries of the condemned areas are based on fecal coliform concentrations

Modeling of WWTF

- Modeling is not straightforward
- Viruses are of greater concern since disinfection largely eliminates bacteria
- FDA recommended min. dilution ratios
  - 1/1000 for chlorine disinfection
  - 1/400 for UV disinfection
- DSS inputs either 1000 or 400 fecal coliforms/100 ml and runs model to 1/100ml

Modeling of Marinas

- Relatively straightforward analyses
- NSSP dictates the values of many parameters
- Entire process is based on fecal coliforms and model down to 14/100ml
- No prohibited areas are required
- Relatively small numbers of boats result in large condemnations since feces is considered to be untreated, as per NSSP

Virginia Department of Health
Finney Creek
Condemned Shellfish Area 097-219
2 March 2006

0   1,000   2,000   4,000
                            Feet

Accomack County

Rose Cottage

Nikawampus Rd

N

Section
A

Nickawampas Cr
14-07-16

Finney Creek
14-05-10

Condemned Shellfish Areas
(Sections A & B)

Seasonally Condemned Shellfish Areas
(Sections M1 & M2)

(37°37'04.9", -75°40'33.3")

(37°37'08.4", -75°40'22.8")

Bunting Point Rd

Burtons Bay
14-05-07

Finney Cr
14-05-10

(37°36'34.0", -75°40'54.7")

(37°36'32.4", -75°40'52.5")

Shields Ln

Drummondtown Rd

Willis St

Town of
Wachapreague

Section
M1

Wachapreague
Channel
14-07-15

(37°36'22.6", -75°41'13.4")   (37°36'22.2", -75°41'11.2")

Main St

Section
B

(37°36'41.7", -75°41'14.0")

(37°36'41.0", -75°41'10.8")

Section
M2

Marlin Ln

(37°35'57.5", -75°40'49.4")

(37°35'54.0", -75°40'49.7")

(37°35'51.0", -75°41'15.0")

(37°35'52.4", -75°41'04.6")

Bradford Bay
14-05-05

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OF HEALTH
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Limitations of Modeling

- Receiving waters are generally not rectangular

- Output is rectangular

- Wind cannot be directly incorporated

- Inability to correctly model influences from other, nearby WWTF

Proposed and Existing Outfalls in Chincoteague Channel
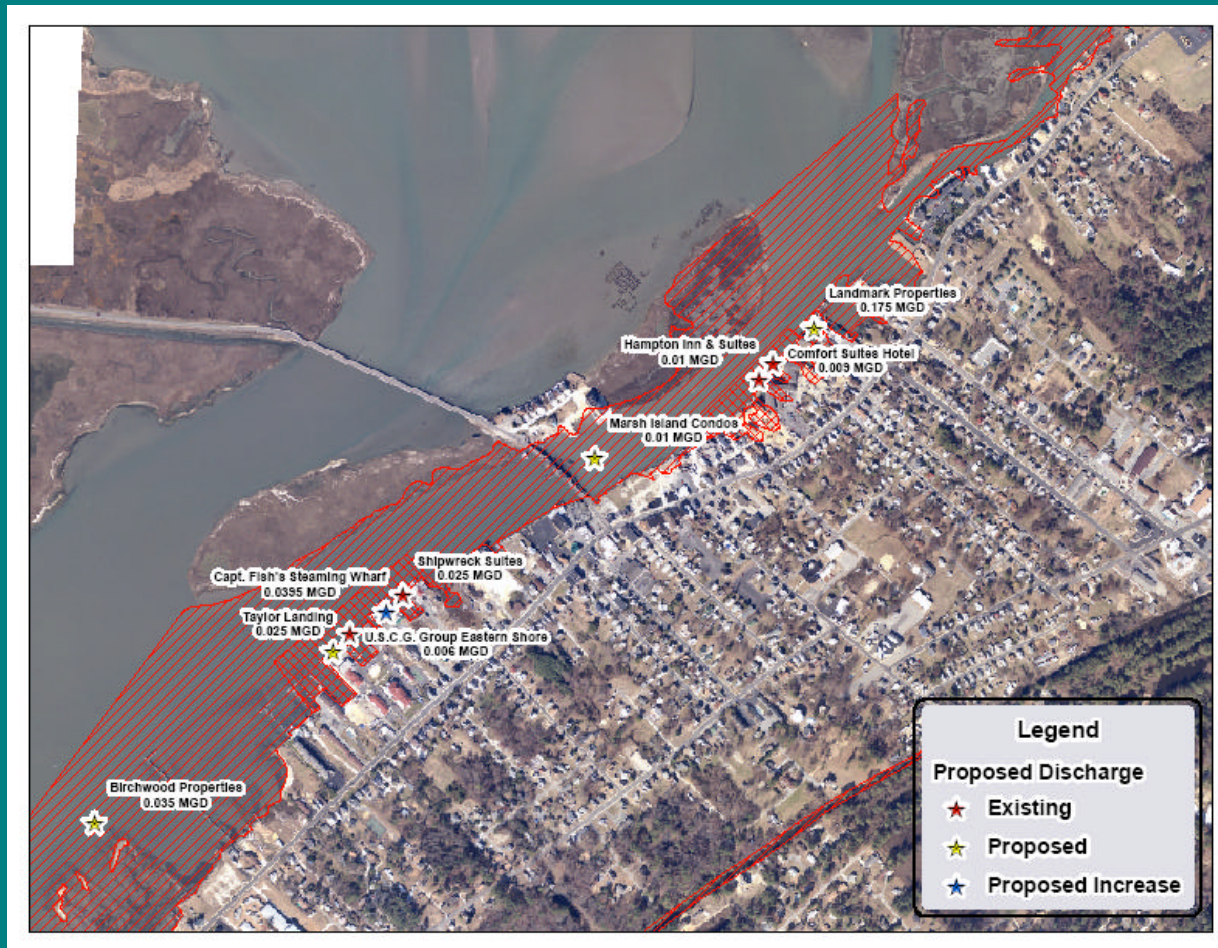
Advantages of Modeling

- In locations where the zone of influence is fairly uniform, the model seems to reflect real world conditions pretty well

- In locations where the zone of influence is irregular, the output is still better than static dilution models

- Can be run in a reasonable amount of time

Dye Studies:
A Verification Tool for Modeling

- Inject small amounts of highly concentrated dye into the proposed or existing outfall location for approximately 9 hours to include an entire ebb or flood tide and parts of the other tidal cycles

- Monitor the concentrations with a fluorometer over the cycle and sometimes the following day(s)

# Advantages and Disadvantages of Dye Studies

- Advantages

  - real world values

  - helps provide verification of math models

- Disadvantages

  - requires a fair amount of technical expertise

  - extremely time consuming

  - valid for environmental conditions at the time

Chincoteague

Approach:

A DC powered pump was used to pull clean water out of the bay.

Dye injected into the flow stream.
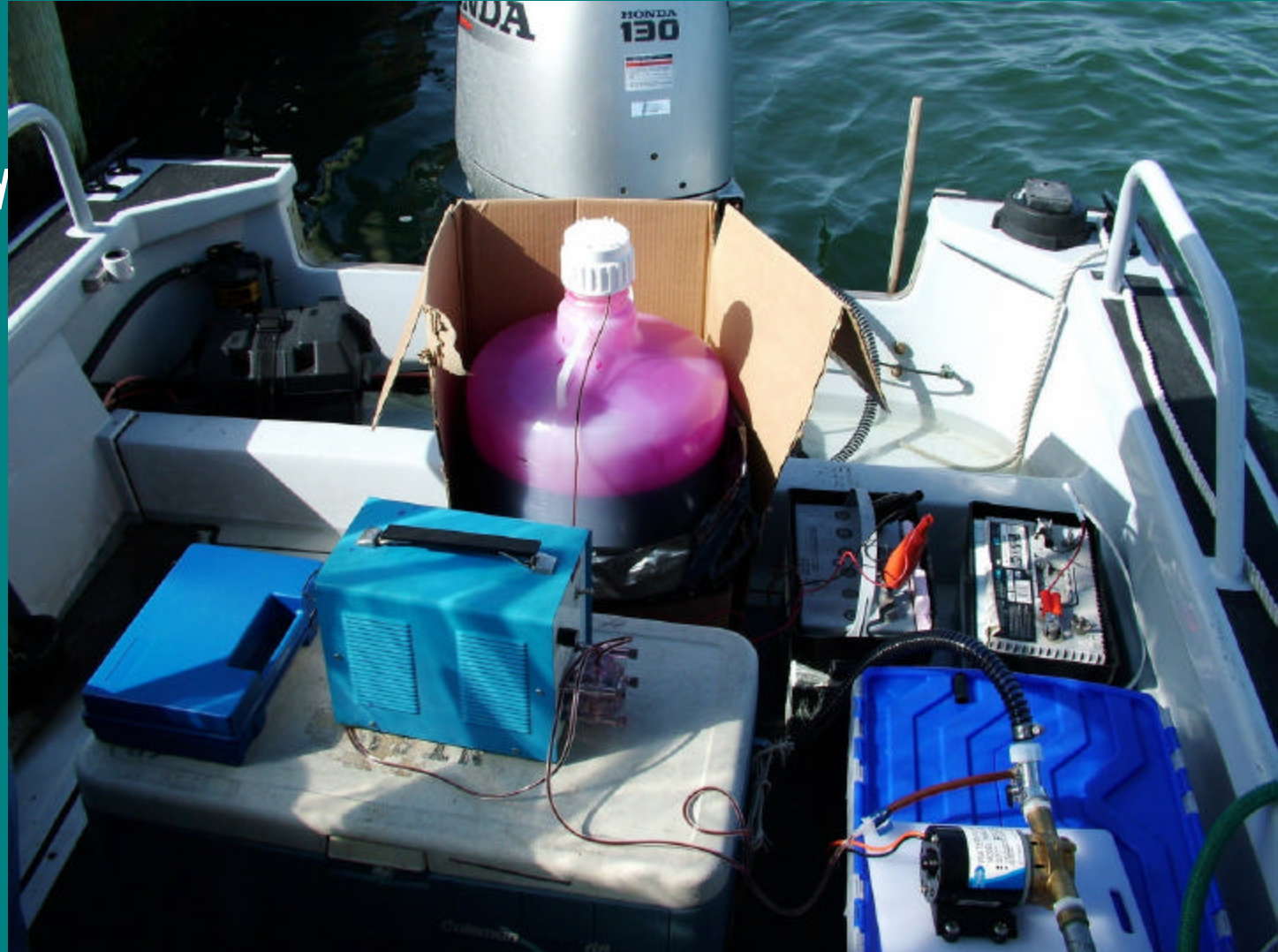
Approach:

Injection –
Started injection during last 3 hours of ebb and into the flood tide. Monitored into the 2nd ebb tide.
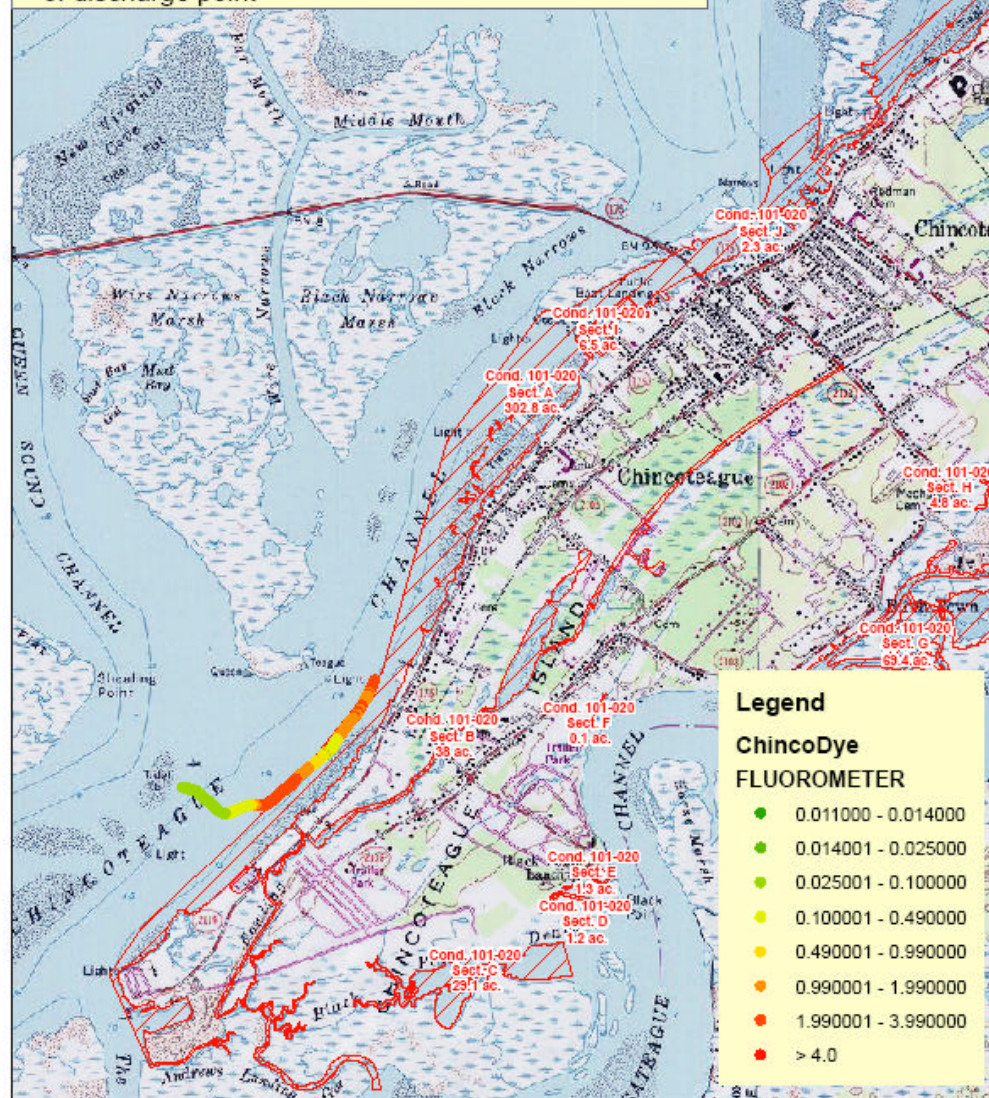

SW

Ebb

NE

Injection – Tide turns from slack to flood (injected another 6 hours)

Flood

# Use of GIS to show dye concentrations digitally correlated using GPS & Panasonic Toughbook

Transect #14
6:52 pm - 7:08 pm
Mid ebb
Field fluorometry values range to a maximum of 3.5 ppm
Depicts plume effects 2.4 miles downstream
  of discharge point

Legend

ChincoDye
FLUOROMETER

- 0.011000 - 0.014000
- 0.014001 - 0.025000
- 0.025001 - 0.100000
- 0.100001 - 0.490000
- 0.490001 - 0.990000
- 0.990001 - 1.990000
- 1.990001 - 3.990000
- > 4.0

Overriding Concerns for Consideration by the TAC

Potential to allow a WWTF discharge into a currently condemned area that might improve later in water quality, but can never be reopened once the discharge is in place
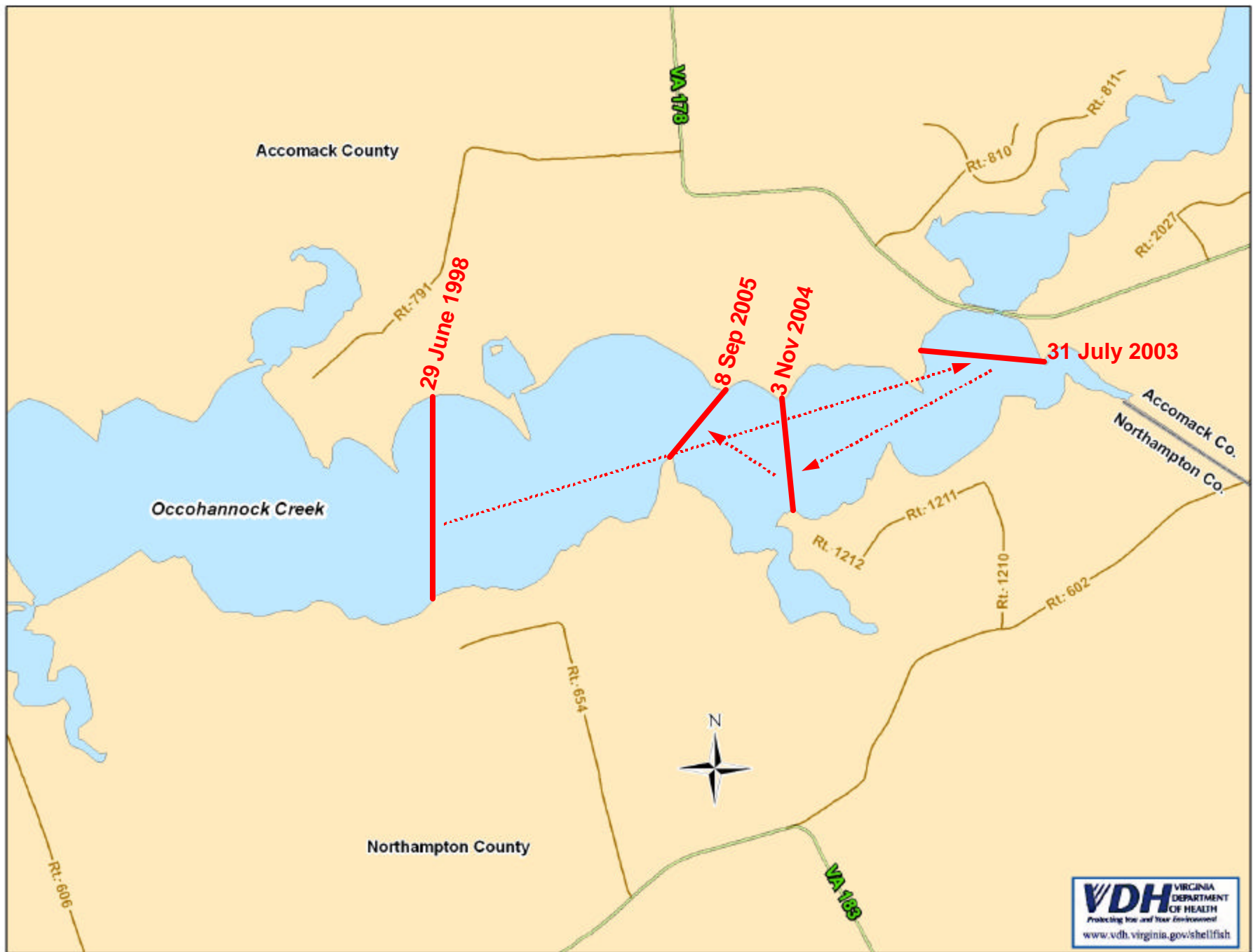
Viral contamination in the vicinity of WWTP outfalls may pose the potential to require the expansion of condemnations in the future

2007-08 *Norovirus* Study Sites
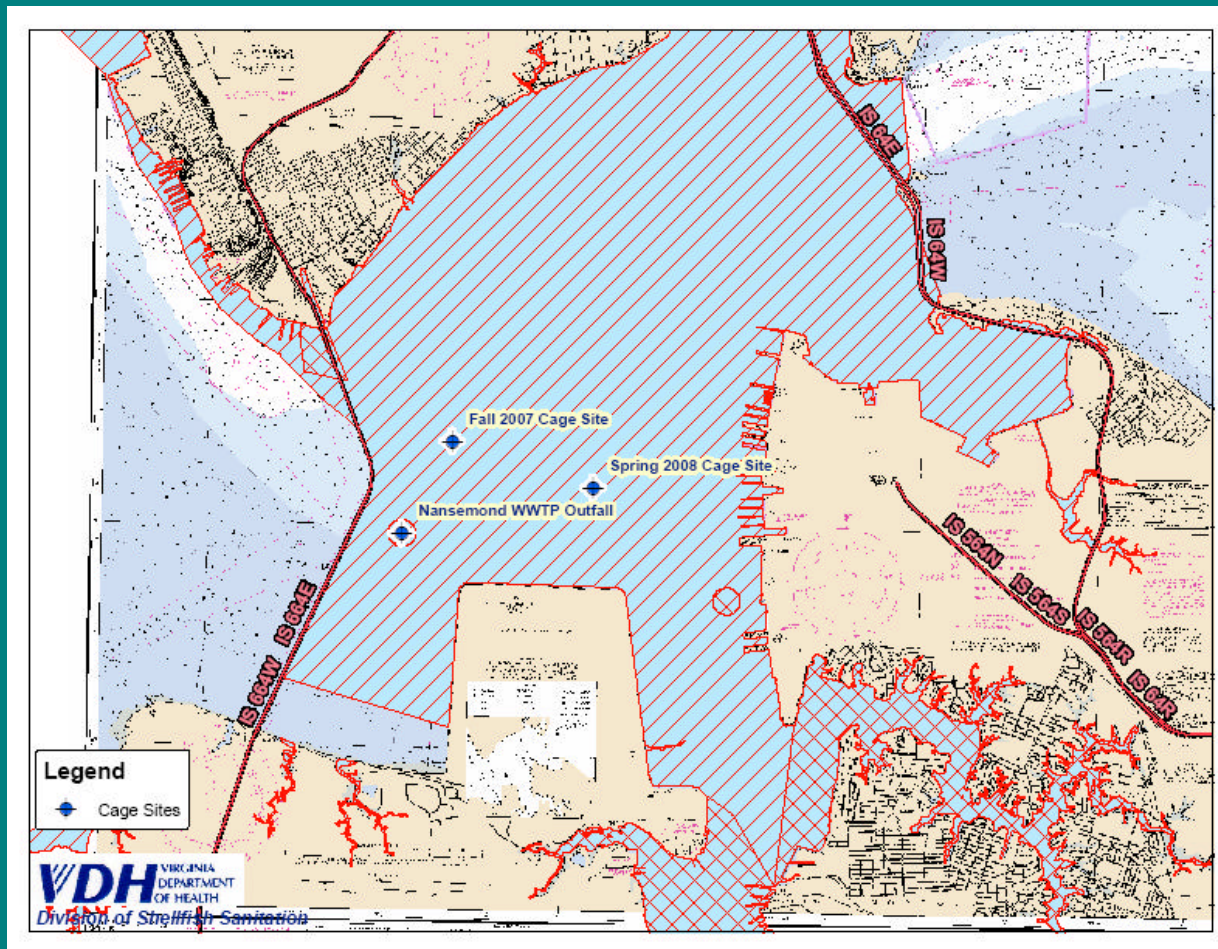
Substances of Unknown Concern in Shellfish from WWTF

Waste water treatment facilities are being proposed with better and better treatment potential requiring smaller buffer zones (*e.g.*, 24-day detention pond)

- we do not know what substances might be accumulated by shellfish when insufficient dilution is provided (*e.g.*, estrogen mimics, antibiotics, etc.)

- FDA and DSS require a sizeable closure to protect against this (1/2 normal treatment size)

Current limitations on new discharges that would create or increase the size of a shellfish condemnation have the effect of squeezing new discharges into existing condemned areas, which generally are the worst places for dilution

The Movement of Shellfish Culture from Offshore to Nearshore Poses New Risks

- Shellfish aquaculture is moving from traditionally deep, offshore waters to shallow, nearshore waters

- Nearshore waters are easily impacted by relatively small amounts of rain-induced runoff and small onshore pollution sources

- State shellfish programs are limited in the number of stations they can monitor and by water depth for maneuvering boats

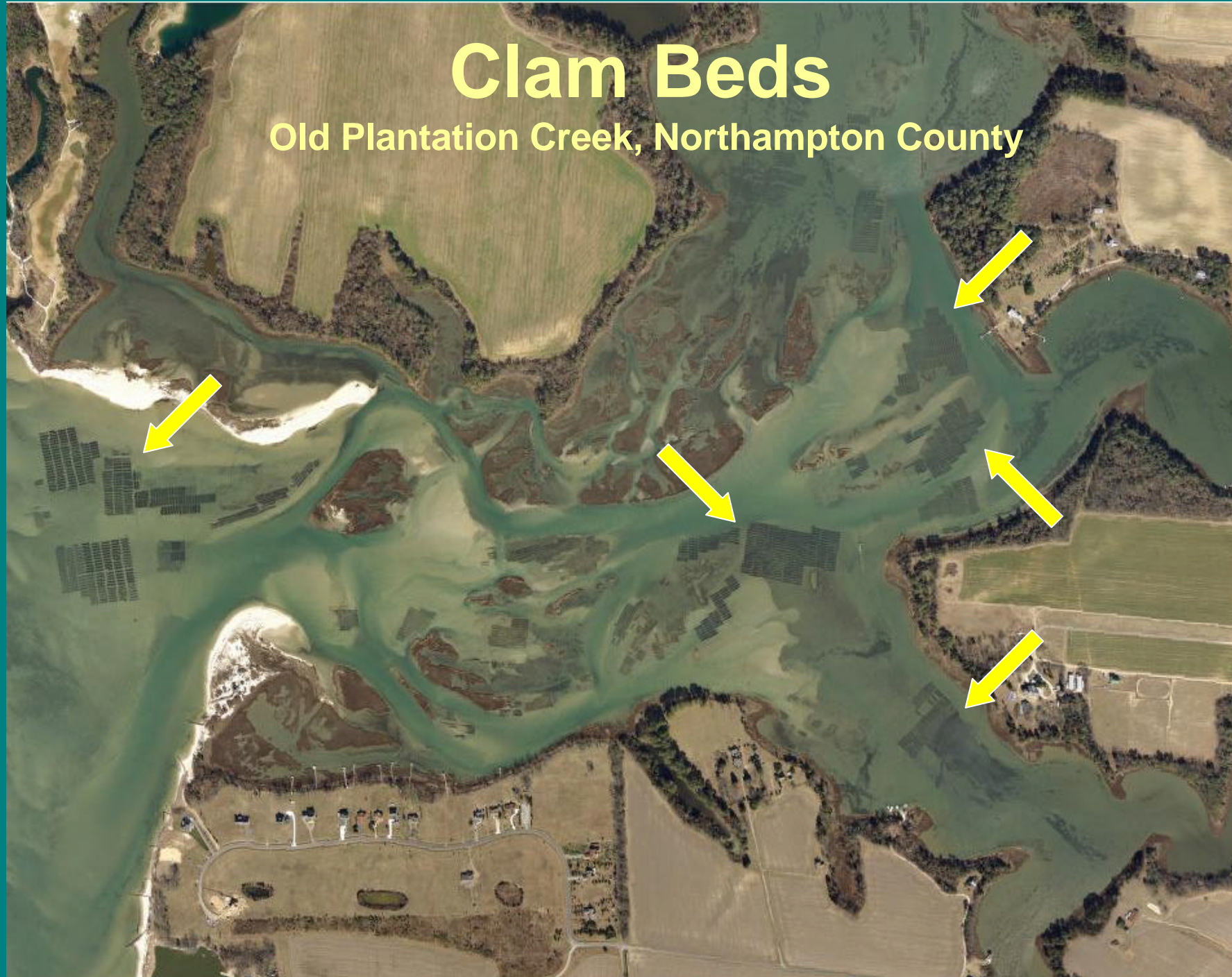- The conservative shellfish standard is needed

Taylor Floats
New Point Aquaculture, Dyer Creek, Mathews County

Clam Beds
Old Plantation Creek, Northampton County

Questions?

©T Fearington